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## Consumers' Preferred Body Scanning Technology: A Comparison

Saiful Islam

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# **CONSUMERS' PREFERRED BODY SCANNING TECHNOLOGY: A COMPARISON**

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Master of Science

in

The Department of Textiles, Apparel Design, and Merchandising

by  
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B.Sc., University of Chittagong, 2012  
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## **Abstract**

Poor fit of apparel products has been troublesome for both the consumers and manufacturers for many years. The acquisition of a correct set of body measurements is crucially important for achieving proper fitting apparel. Three-dimensional body scanning technology has been recognized as a promising alternative to the traditional measuring tape method of obtaining body measurements. Three-dimensional body scanners are quick, efficient, highly reproducible, and largely free of error related to human intervention.

The purpose of this study was to investigate consumers' preferred type of body scanning technology. Three types of body scanners (traditional body scanner, suit-based body scanner, and mobile-based body scanner) were compared using the Technology Acceptance Model (Davis, 1989) as the theoretical framework. Consumers' perception on usefulness and ease of use were compared among the three scanner types.

An online survey was administered using Qualtrics<sup>®</sup> software for data collection. Data included 382 responses, out of which only 220 were valid. Data was analyzed using SAS<sup>®</sup> software to test formulated hypotheses. Findings indicated that participants' perceived usefulness did not vary across the three types of body scanners, but the mobile-based body scanner was perceived to be easier to use than the traditional body scanner. The suit-based body scanner was perceived to be easier to use by men. Gender did not have any significant effect in the preference of the traditional and the suit-based body scanner, but gender was a significant source of variation in preference of the mobile-based body scanner.

## **Chapter 1. Introduction**

The search for perfectly-fitted apparel has long been a struggle for both young and old consumers (Apeagyei, 2010; Istook, 2008; Lee, Damhorst, Lee, Kozar, & Martin, 2012; Shin & Baytar, 2014). Poor fit accounts for a significant amount of clothing dissatisfaction among consumers. According to one study (Kunst, 2019), 43% of surveyed consumers expressed dissatisfaction regarding the fit of apparel purchased online. Accurate fit of apparel products greatly depends on the acquisition of a complete set of correct measurements of the human body (Apeagyei, 2010). Thus, there has been continuous efforts toward finding the most efficient and accurate method of measuring the human body.

Researchers and anthropologists adopted different techniques in the past to accurately measure the human body. They experimented with conventional measuring tapes, sliding gauges, calipers, and algin or gypsum molding to get a three-dimensional representation of the human body (Fan, Yu, & Hunter, 2004). Even though they were successful to some extent, the expensive nature and clumsy procedure of the developed methods restricted the wide application of those processes. For example, measurement with a conventional measuring tape greatly depends on the skill of the measurer, the sliding gauge technique was bulky, and the use of the algin or gypsum application was too expensive to practice commercially (Fan et al., 2004).

In order to overcome the shortcomings of previous technologies, researchers devoted their effort to developing three-dimensional body scanning technologies to get the 3D representation of human body (Fan et al., 2004). The Loughborough Anthropometric Shadow Scanner (LASS) was the earliest 3D body scanner developed at the Loughborough University and patented in the UK (Braganca, Arezes, & Carvalho, 2015). This scanner could scan the entire human body in only three minutes (Braganca et al., 2015). Since then, many 3D body



scanners have been developed based on white light, infrared, laser, and mobile camera technologies (Braganca et al., 2015). Most of the 3D body scanners developed after the 2000s use infrared depth sensors, laser technology, and white light mobile cameras to scan the human body (MTailor, 2019; Size Stream, 2019a, 2019b).

Three-dimensional body scanning is a non-contact method of measuring the human body. This process is highly accurate, quick, efficient, and reproducible (Braganca et al., 2015; Gill, 2015a). The measurements extracted from 3D body scanners can be directly transferred into patternmaking software like Optitex, making the process free from errors related to human intervention (Gill, 2015a). When it was once considered a luxury, 3D body scanning technology has made custom-made clothing a reality for many consumers (Drake, 2007).

Many retailers have adopted 3D body scanning technology to offer custom fit clothing to their customers. Retailers like Levi's® and Land's End® used 3D body scanning data to determine the right size for individual customers (Ives & Piccoli, 2003). They could also create custom-made garments if the size was not available in stock to fit the customer (Istook, 2008).

These early trials by retailers indicated that 3D body scanning technology had great potential for successfully being employed in the apparel industry. But the successful implementation of this technology largely depends on the wide acceptance of body scanning by consumers. Research suggested that men and women were equally likely to adopt body scanning technology (Drake, 2007). However, researchers revealed different concerns and issues among consumers related to the adoption of body scanning technology. Some consumers were not comfortable with the scanning procedure, while others were not happy to see their body on the computer screen after getting scanned (Heuberger, Domina, & MacGillivray, 2010; Ridgeway,

2018). Additionally, some consumers were hedonically motivated to get a body scan but did not find the technology useful (Rzepka, 2011).

Aside from retailer applications, 3D body scanning technology can provide hundreds of measurements in a matter of seconds, which made nationwide anthropometric surveys possible (Apeagyei, 2010; Istook, 2008). Three-dimensional body scanning technology was used in nationwide surveys in different parts of the world like project CAESAR, SizeUK, SizeUSA, SizeKorea, and SizeMX (Ashdown, Loker, Adelson, Schoenfelder, & Lyman-Clarke, 2002; Istook, 2008; Robinette, Daanen, & Paquet, 1999; Yim Lee, Istook, Ja Nam, & Mi Park, 2007). These surveys were carried out in the respective geographic locations to get body measurement data representative of current populations. These data were further used by apparel retailers for mass customization and updating sizing charts (Istook, 2008).

Other than the apparel industry, 3D body scanning technologies have been used in the medical industries and in airports for security purposes (Bindahman, Zakaria, & Zakaria, 2012; Treleaven & Wells, 2007). For instance, 3D body scanning technology was being researched to monitor changes in the development of chest wall deformity and to identify the volume of burned skin area for treating patients (Katashev, Romberg, Danielsson, & Saraste, 2015; Treleaven & Wells, 2007). Besides, 3D body scanning technologies have been deployed in different airports throughout the US and Europe as a replacement for traditional pat down method of searching to prevent terrorist activities (Bindahman et al., 2012).

Clearly, 3D body scanning technology has a wide range of possible applications. And therefore, there were some very different types of body scanners commercially available. For instance, the SS20 3D body scanner from Size Stream<sup>®</sup>, one of the market leaders in the body scanning technology market, used infrared depth sensors to extract measurement from 600 data

points (Size Stream, 2019a). This machine took about 10 seconds to complete a scan and 30 seconds to extract measurements (Size Stream, 2019a). Another recent 3D body scanning technology from Size Stream<sup>®</sup> was Size Stream @ Home<sup>®</sup>, which used a scan suit and a mobile camera to perform scans (Size Stream, 2019b). Size Stream @ Home<sup>®</sup> could be used to extract body measurements for clothing fit purposes and for monitoring health improvements such as changes in body measurements or percentages of fat in the body (Size Stream, 2019b).

Another type of mobile based body scanning technology was available through the MTailor<sup>®</sup> mobile app. This app was free from the suit making company, MTailor<sup>®</sup>, and available for both iOS and android devices (MTailor, 2019). Customers could use this app to determine their size and shop from the company website (mtailor.com). The MTailor<sup>®</sup> app used a mobile camera to record a video of the individual customer and used artificial intelligence to extract nine upper body measurements and seven lower body measurements to predict size (MTailor, 2019).

Each of these types of commercially available body scanners had pluses and minuses when it came to implementation for the apparel industry. Before retailers made the investment in body scanning technology, it was critical to understand how consumers viewed each of the available scanner formats. Therefore, it was crucial to explore consumers' preferred type of body scanning technology.

### **1.1. Purpose**

The purpose of this research was to find out consumers' preferred type of body scanner using the Technology Acceptance Model (Davis, 1989) as a framework. These were a conventional body scanner that worked on infrared technology (Size Stream<sup>®</sup> SS20), a suit-based scanner that used a scanning suit and mobile camera (Size Stream @ Home<sup>®</sup>), and a mobile-based scanner (MTailor<sup>®</sup>). The Technology Acceptance Model (TAM) was utilized to determine

consumers' adoption behavior in terms of perceived usefulness and perceived ease of use among the three types of body scanning technologies. Moreover, the effect of gender in the preference of body scanning technology was assessed.

## **1.2. Hypotheses**

To explore the purpose statement, the following hypotheses were developed:

H1: There will not be a significant difference in the perceived usefulness of the three types of body scanning systems.

H2: The mobile-based scanner will have higher perceived ease of use than the traditional body scanner.

H3: The suit-based scanner will have higher perceived ease of use than the traditional body scanner.

H4: The suit-based scanner will have a lower perceived ease of use for women than men.

H5: There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology.

## **1.3. Specific Objectives**

Objectives of this study in relation to the hypotheses developed were as follows:

- Identify consumers' preferred type of body scanning technology
- Measure differences in perceived usefulness among three types of body scanning technologies
- Determine consumers' preference of body scanning technologies in terms of perceived ease of use
- Assess consumers' preference of body scanning technologies in terms of perceived usefulness

- Determine the differences in preferences for body scanning technologies between men and women

#### **1.4. Assumptions**

This study was conducted under the following assumptions:

1. All participants were at least 18 years old.
2. All participants were living in the US.
3. Self-reported demographic information was factual.
4. All survey responses provided by the participants were factual and representative of the individuals' opinions.

#### **1.5. Scope and Limitations**

Scopes and limitations for the current study were identified as follows:

1. It was not possible to show the body scanners to the participants physically. The researcher acknowledged that the perception may be different when participants actually use these technologies.
2. The collection of quantitative data related to the participants and could not be generalized to the entire population.

#### **1.6. Definitions**

The following terms were defined in order to better understand the research:

Anthropometry	“Anthropometry is the systematic measurement of the physical human form” (Kennedy et al., 2019, p. 1).
Body Dissatisfaction	“Body dissatisfaction is the subjective negative evaluation of one’s figure or body parts” (Presnell, Bearman, & Stice, 2004, p. 389).

Body Scanning	“Body scanning is the term generally used for the technology employed to capture the 3D surface of the body, most often by light projection and image capture technology and to render this into electronic environments” (Gill, 2015b, p. 17).
Consumer Behavior	“The study of the processes involved when individuals or groups select, purchase, use or dispose of products, services, ideas or experiences to satisfy needs and desires” (Hogg, Askegaard, Bamossy, & Solomon, 2006, p. 6).
Infrared Depth Sensor	“Known as ‘active depth sensing’ it will use infrared light and shine it in a particular pattern so that a sensor can then measure the distortion in the pattern. A device will then be able to calculate and produce an incredibly accurate 3D image of the scene” (Nicholls, 2017, para 4).
Mass Customization	“The mass production of individually customized goods and services” (Pine, Pine, & Pine, 1993, p. 48).
Size Prediction	“Size prediction is an online service that identifies the specific brand and size within the brand that should fit each individual best” (Lee et al., 2012, p. 111).

## **Chapter 2. Literature Review**

Three-dimensional body scanning technology has tremendous potential for the apparel industry. Though it is currently being utilized in other fields, like gaming and various medical industries, the apparel industry has not yet fully embraced this technology. The successful implementation of 3D body scanning technology largely depends on wide-scale acceptance by consumers. Therefore, the purpose of this research was to find out consumers' preferred type of body scanner using the Technology Acceptance Model (Davis, 1989) as a framework. This study further explored differences in preferred type of body scanning technology between men and women. This chapter will highlight the development of 3D body scanning technology, working procedures, types of body scanners available in the market, application of this technology, and mass customization.

### **2.1. Body Scanning**

Custom garments with excellent fit are greatly correlated to the ability to obtain accurate sets of measurements (Apeagyei, 2010). Thus, the acquisition of an accurate and comprehensive set of measurements is highly important for making custom fitted garments. Previously, anthropologists used conventional measuring tapes and calipers to obtain measurements of the human body (Bourgeois et al., 2017). These hand measurement methods were most often inaccurate, inefficient, and time consuming (Istook, 2006). The development of non-contact 3D body scanners seemed to be a promising solution to the conventional measurement techniques because they are relatively quick, more accurate, and provided ample amounts of data regarding body measurements, volume and surface geometry (Braganca et al., 2015; Drake, 2007; Gill, 2015a; Istook, 2006). Body scanning technology has also paved the way for obtaining less expensive, tailored fit products possible, which was once considered a luxury (Drake, 2007).

Researchers have embraced 3D body scanning as a method of obtaining anthropometric data (Heuberger, Domina, & MacGillivray, 2008; Istook & Hwang, 2001; Treleaven & Wells, 2007). There are numerous applications of this technology that can help to improve fit, mass customization, and apparel product development (Al-Mousa, 2011; Drake, 2007; Fiore, Lee, & Kunz, 2003; Ridgeway, 2018; Wu, Pribil, & Ashdown, 2013). 3D body scanning technology has been used in conducting nationwide surveys, in mass customization for apparel product development, and in medical fields (Drake, 2007; Istook, 2008; Treleaven & Wells, 2007).

## **2.2. History of Body Scanning Technology**

The 3D digitization of the human body and clothing surface is very important for the spatial analysis of apparel fit and appearance (Istook & Hwang, 2001). There have been continuous developments to help integrate this technology into the apparel industry. Researchers and developers have tried many different techniques and technologies to record three-dimensional, nonlinear measurements of human subjects. This section of the literature review will document some of the major advancements in body scanning technology from the early 1800s to present day.

### **2.2.1. The 1800's**

Since the late 1800's, anthropologists used conventional measuring tape and calipers for measuring the human body (Fan et al., 2004). Measurements obtained using these processes greatly depended on the individual's skillset and could vary significantly between two anthropologists (Istook, 2006). These processes required precision and a great deal of time to measure one individual, making these processes inefficient, inaccurate and time-consuming (Istook & Hwang, 2001). Therefore, researchers all over the world began to develop tools to attain more reliable and efficient ways to record human body measurements.



Researchers were also keenly interested in obtaining the profile of the human body. The idea of 3D body scanning was adopted from Leonardo da Vinci, who had a fascination with human body surveys (Fan et al., 2004). The development of 3D body scanning technology has occurred mainly in three geographic locations: Asia, America and Europe.

### **2.2.2. Early Developments**

Different types of non-conventional measuring devices like the sliding gauge, gypsum molding, silhouette, moire camera, infrared, and a laser scanner were developed in Japan to capture the two dimensional and three-dimensional profiles of the human body (Fan et al., 2004). The development of a 3D body scanner from the conventional tape measuring system was a step-by-step progression in Japan, which began with the sliding gauge. The development of the sliding gauge was a great achievement over the conventional tape measurement. A series of aluminum sticks of 5mm diameter having same length were used to draw the 3D profile of human subjects. The sticks were pushed toward the human body and the other end of the sticks were drawn on paper for further calculation of body measurements of cross-sectional areas. Later, a mechanical version of the sliding gauge was developed for more efficient measurements, but these devices were not widely used because of their bulkiness and clumsy operating procedure (Fan et al., 2004).

Japanese researchers also used algin or gypsum for obtaining a continuous 3D measurement of the human body (Fan et al., 2004). The researchers brushed the liquid material directly on the body and allowed it to dry. This would create a mold of the 3D form that could be taken off the body when fully dried. The inner part of the mold was used to record the shapes and measurement of the human subject under investigation. This method was not popular because of its expensive nature (Fan et al., 2004).

The next major advancement utilized laser technology. Laser equipped systems were eventually developed in the late 1970s. The human body was studied as a 3D object using laser technology starting in 1973 based on light sectioning technique as proposed by Lovesey (Lovesey, 1966). In 1977, Clerget, Germin, and Kryze were able to illuminate an object with a laser beam for the first time in order to take measurements (K. Simmons & Istook, 2001).

### **2.2.3. The 1980's**

In 1980 an American company, Cyberware, developed scanners that could scan parts of the human body such as the head, face and other body parts (Istook & Hwang, 2001). Some other researchers at that time were inspired by photography and created photography-based methods to obtain measurements of the human body. Researchers used shadow moire topography in academic research for outlining the 3D view of the human body and its relationship with clothing patterns (Fan et al., 2004). The Japanese company Fujinon produced a moire camera in 1980s using projection moire topography (Fan et al., 2004). This camera was mainly used to identify spinal deformities among school children (Fan et al., 2004).

Japanese researchers developed a 'Silhouetter' in 1984 to capture the 2D photographs of human body contour against a calibrated standard grid wall (Fan et al., 2004). A large grid wall located inside a booth, a series of fluorescent lights, and an instant camera were used in this system. A computerized silhouette analyzer was developed by Wacoal in 1984 to process this type of contour data electronically (Fan et al., 2004).

In 1985, American researchers David and Lloyd Addleman developed the first laser beam system, which is sold today as Cyberware (Fan et al., 2004). In 1987, laser body scanners became capable of measuring and digitizing human body surfaces (Fan et al., 2004). Nowadays, laser scanners comprise the majority of 3D body scanners available in the market (Istook, 2006).

While laser scanning technology was popular in the 1980s, other technologies for gathering body measurements were available. One of the earliest body scanning technologies based on the shadow scanning system was developed in Loughborough University. A scanner that is different than the moire topography technique called shadow scanner was available at that time (Braganca et al., 2015; Istook & Hwang, 2001). This Loughborough Anthropometric Shadow scanner (LASS) was developed based on triangulation. The LASS, the first 3D scanner to be patented in the UK in 1985 (Istook, 2008). The LASS took only three minutes to record 3D measurements of the entire human body (Jones, West, Harris, & Read, 1989). It was an automated computerized 3D measurement system where the human subject was made to stand on a rotating platform (Jones, Li, Brooke-Wavell, & West, 1995). A series of cameras placed on a column captured images as the platform rotated in measured angular increments. Those images were used as the input for the computerized reconstruction of the 3D image (Bouguet & Perona, 1998). The height and the horizontal radii of the subject were calculated from the images recorded by the camera. Data obtained from the images are three-dimensional coordinates of the body in cylindrical form (Jones et al., 1995).

#### **2.2.4. The 1990's**

Body scanning technology continued to advance in the next decade. The Voxelan 3D body scanner was originally developed by the company NKK<sup>®</sup> in Japan and later acquired by Hamano Engineering Company<sup>®</sup> in 1990 (Fan et al., 2004). They offered laser scanners for the whole-body, half body, and head measuring units (Fan et al., 2004). In the same year, Fujinon's<sup>®</sup> moire camera was made commercially available in the market and was widely used because of its light weight and portability (Fan et al., 2004). However, there were problems in automatic processing of moire images as they frequently contained noise that distorted the final image.

Therefore, researchers shifted their attention to laser and infrared technologies in the 1990s (Fan et al., 2004).

Hamamatsu and Hokuriku were major Japanese companies that sold infrared body scanners in the 1990s (Fan et al., 2004). Conusette<sup>®</sup>, a product of Hokuriku<sup>®</sup>, was mainly designed for the customization of ladies' foundation garments. These products could only analyze the upper torso of a scanned body. The company also provided a whole-body scanning unit later on. This system was used to suggest the most suitable underwear for a given body shape. Future bodily development and aging were simulated using computer graphics to demonstrate what the figure would look like in five to ten years depending on the current body shape. Then, the current body shape was superimposed on the projected future body shape to allow ladies to formulate diet, fashion and healthcare plans (Fan et al., 2004).

In May 1995, Cyberware<sup>®</sup> introduced the first 3D body scanner capable of capturing the color and shape of an individual in one pass (K. P. Simmons, 2001). This scanner was used to measure individuals in the United States Air Force to make perfectly fitted uniforms (Istook & Hwang, 2001). The French Navy also used an automated 3D body measurement system called SYMCAD developed by Telmat Industrie<sup>®</sup> to improve uniform fit among soldiers (Soir, 1999). The new 3D version of SYMCAD is still used in the clothing industry today (Istook & Hwang, 2001) as it is capable of capturing the 3D shape of the human body instantly and automatically processes each measurement with an accuracy of  $\pm 2$  mm (Turner, 1994). The German company, Tecmath<sup>®</sup>, began providing similar 2D and 3D body scanners called Vitus<sup>®</sup> in 1995 (Fan et al., 2004).

In 1996, a 3D measurement system named Auto-Mate<sup>®</sup> was developed by the United Kingdom's Defense Clothing and Textile Agency (DCTA) in collaboration with researchers at

the National Engineering Laboratory (Fan et al., 2004). In the same year, a teaching hospital in London and Wicks and Wilson partnered to develop the TriForm<sup>®</sup> system based on the old moire fringe technique (Istook & Hwang, 2001). This system has been used to track the health and improvement of their club members throughout the UK by David Lloyd Leisure Centers (Fan et al., 2004). The Triform<sup>®</sup> system was also employed in a sizing survey in the UK sponsored by renowned apparel retailer Marks and Spencer (Istook & Hwang, 2001).

#### **2.2.5. The 2000's**

In 1998, the American company, TC<sup>2</sup><sup>®</sup> made their 3D body scanners commercially available (Fan et al., 2004). Their system was used in different national surveys, namely in the SizeUK project in 2000, SizeUSA in 2002, and Size MX in Mexico in 2004 (TC<sup>2</sup>, 2019).

In that same period of time, a computer-aided system was developed at the Hong Kong University of Science and Technology (HKUST) for 3D mannequin generation and garment design within the digital world (Fan et al., 2004). The machine had a parametric, feature-based design which could produce digital mannequins of men, women, and children of different ages using twelve images taken with digital cameras at six different angles and two levels. Digital garment patterns could be graphically sewn to be overlaid on the CAD mannequins and could simulate different fabric effects (Fan et al., 2004). This system was the early version of modern virtual try-on technologies.

In the early 2000s, a low-cost body scanner called CubiCam<sup>®</sup> was patented by a researcher attached to the Hong Kong Polytechnic University (Fan et al., 2004). The CubiCam<sup>®</sup> was the smallest body scanner in the market measuring only 160 mm W X 405 mm D X 390 mm H. It worked on moire topography technique. It used only one camera to capture images making the process swift. The machine capture an image within a split second (1/1500<sup>th</sup> of a second)

under normal lighting conditions (Fan et al., 2004, p. 142). The CubiCam® did not use lasers, infrared or any other harmful radiations, making it completely safe to use. It had six ‘S’ advantages, which were namely small, slim, saving, simple to use, swift, and safe (Yu, Ng, & Yan, 2001).

The Industrial Technology Research Institute (ITRI) in Taiwan developed Gemini®, a portable 3D scanner, which worked on opto-electronic technology (Fan et al., 2004). Gemini® used six optical detectors to avoid blind spots, the detectors performed simultaneous scans all around the subject. A laser beam was projected on the human subject under investigation to perform the body scanning (Fan et al., 2004). ITRI installed a body scanner at Chang Gung Memorial Hospital in February 2000 for collecting 3D data of human subjects. At the end of 2002, they had scanned 4,500 people (Fan et al., 2004). Even though, Gemini® was primarily intended for medical use, but eventually ITRI linked the system to the Taiwan Data Bank to provide body measurements related information to apparel manufacturers.

In 2001, a non-contact type of 3D measurement device called Cubic® was invented at Bunka Women’s University in Japan (Fan et al., 2004). It used halogen lights and took about one second to record whole-body measurements. Depending on the image coverage, this system had an accuracy of 1 to 3 mm for each measurement taken. This machine was comparatively light in weight and provided customized software to users depending on their needs (Fan et al., 2004).

#### **2.2.6. The 2010’s**

A whole host of body scanning technologies became available in the 2010s. Some of these (e.g. Styku®, Fit 3D®, Size Stream @ Home® etc.) are more suitable for gym/fitness environments because they captured fewer key measurements, allowing users to track their fitness through changes in measurements (Treleaven & Wells, 2007). Other machines (e.g. TC<sup>2</sup>®,

SizeStream<sup>®</sup>) take hundreds of measurements in relatively small amounts of time, making them suitable for sophisticated anthropometric research (Istook, 2008). Finally, some companies like MTailor<sup>®</sup> are using commercially available cellphones wielded by consumers to capture critical measurements for the development of custom apparel products (MTailor, 2019).

American company, Size Stream<sup>®</sup>, LLC is a market leader in 3D body scanning industries. The company was founded in 2012 (Size Stream, 2019b). Since then, they have expanded worldwide. The SS20 3D body scanner works using infrared techniques. It uses 20 infrared depth sensors to perform full body scans. It takes around ten seconds to scan the whole body and less than 30 seconds to process the scanned data. Each scan produces two million data points of the whole body and uses 600 data points to extract measurement. This machine has an accuracy of about +/- 5mm (Size Stream, 2019b).

Size Stream @ Home<sup>®</sup> is the latest addition in the body scanning technology market. According to Size Stream (2019a), this machine uses a scan suit (top, leggings and head band), a scan mat, a scan pole and one optional wide-angle camera (for scanning in small rooms) to capture the 3D image of a human subject. It takes about 30 seconds to complete the scan. This technology then uses a mobile application developed by Size Stream<sup>®</sup> to create a 3D version of the individual. Size Stream<sup>®</sup> claims that the at home scan is accurate enough to produce a true 3D version of the individual, while other mobile based scanning technologies use statistics to produce generalized 3D models of the human subjects. According to their website, Size Stream @ Home<sup>®</sup> can be used to track workout progress and order custom garments (Size Stream, 2019a).

The system used by MTailor<sup>®</sup> is one of the other types of non-contact 3D body scanning technologies currently being utilized (MTailor, 2019). MTailor<sup>®</sup> is a custom men's tailored

apparel company that works on a mobile platform. The MTailor<sup>®</sup> app uses a cellphone camera to capture video and extract nine upper body measurements and seven lower body measurements in under 30 seconds to make custom fitted shirts, t-shirts, blazers, chinos, and dress pants for men. They have recently launched a jeans collection for women. They claim their measurements to be 20% more correct than the same measurements taken by professional tailors (MTailor, 2019).

The Naked<sup>®</sup> body scanner was recently developed as a low cost, space efficient body scanner which works on three-dimensional optical imaging technology (Naked Lab, 2019). This scanner is capable of reporting and tracking individual customers' health assessment allowing customers to monitor their own health through measurements without any help from professionals (Kennedy et al., 2019). This system uses three infrared sensors to capture images. 4GB of raw data are sent to the server of Naked Lab<sup>®</sup> and are converted into a 3D image (Naked Lab, 2019). Customers can access their 3D image through the app developed by Naked Lab<sup>®</sup> in their mobile phones (Naked Lab, 2019). This system monitors health improvements by tracking nine key measurements over time within 5mm accuracy (Naked Lab, 2019). These measurements are chest, upper arms, upper thighs, mid thighs, stomach, hips, shoulders, waist, and calves (Naked Lab, 2019). Customers can visualize their body changes using a side by side comparison. The Naked body scanner can also track lean mass, body fat percentage, fat mass, and weight (Naked Lab, 2019). Kennedy et al. (2019) reported no significant variation in fat percentage estimation between the Naked Body Scanner<sup>®</sup> and a Dual-Energy X-ray Absorptiometry, which is frequently used in the medical field to track these numbers. Therefore, the Naked Body Scanner<sup>®</sup> is a highly effective tool for monitoring health at home.



### **2.3. Functions of a 3D Body Scanner**

3D body scanners work without physical contact with the body. These scanners provide data of greater depth than conventional measuring methods (Bye, Labat, & Delong, 2006). The 3D body scanning process accurately assesses the human body using light (laser or infrared) and image capturing devices (Grogan, Gill, Brownbridge, Warnock, & Armitage, 2016). This technology is capable of capturing any type of measurement of the human body.

Most modern 3D body scanners are light-sensitive devices that use optical techniques for capturing the outer surface of the human body (Bindahman et al., 2012). The scan subjects are required to change into tight-fitting clothes such as briefs, bicycle or running shorts, and tank tops or bras for the scanning process (Istook & Hwang, 2001). Body scanners include one or more light sources or vision/capturing devices, computer system, software for data processing, and a monitor screen to visualize the processed data (Istook & Hwang, 2001). Structured light or laser beams are projected from the light source onto the human body; they bounce back and are recorded by the capturing devices (Istook & Hwang, 2001). The data are used to create point clouds of 300,000 to over one million with X, Y, and Z coordinates for creating a 3D object of the human body (Gill, 2015a). This data is processed to create a 3D avatar to extract measurements. The avatars allow analysis of individual body shapes and custom measurement extraction (Apeagyei, 2010). This data can be used to further classify body shape and size to support product development.

Body scanning is widely recognized as a highly accurate measurement tool (Apeagyei, 2010; Ashdown et al., 2002; Gill, 2015a). Bougourd, Dekker, Ross, and Ward (2000) compared measurements from 3D body scanners and traditional measurement methods and found that the measurements were comparable. The benefits of body scanners are the speed of whole-body

measurement, the use of a contactless measurement technique, the availability of the data, and the reproducibility of the technique for multiple subjects (Fan et al., 2004; Istook & Hwang, 2001).

There are some disadvantages of 3D body scanning technology compared to conventional techniques as well. Often the subject has to maintain a fixed posture throughout the scanning process, which can be physically taxing or if the subject moves during the scan, the measurements can be affected. Sometimes there is missing data for body parts like armpits and crotch areas because of shading or the inability of the scanner to accurately read these areas (Gill, 2015a). There are also some other problems associated with light absorption by the hair and skin color (Daanen & van de Water, 1998).

## 2.4. Types of Body Scanners

Primary types of 3D body scanners use light or laser units. Though there are other types of body scanners, most are not used for human body shape scanning purposes. Different types of body scanners are listed in the following table (Istook & Hwang, 2001).

Table 2.1. Types of Body Scanners

System	Company	Products
Light-based system	Hamamatsu	Body lines scanner
	Loughborough University	The Loughborough Anthropometric Shadow Scanner
	TC <sup>2</sup>	2T4, 3T6
	Wicks and Wilson Limited	TriForm, TriForm BodyScan, TriForm3 (Torso Scan), TriForm2 (Headscan), TriForm1
	Telmat	SYMCAD 3D Virtual model

(table cont'd)

System	Company	Products
Light-based system	Turing	Turing C3D
	Puls Scanning System GmbH	Puls scanning system
	CogniTens	Optigo 100 system
Laser-based system	Cyberware	WBX, WB4
	TecMath	Vitus Pro, Vitus Smart
	Vitronic	Viro-3D (4L 8C ST), Viro-3D (4L 16C DT), Viro-3D (4L 16CDT colour), Viro-3D
	Hamano	VOXELAN
	Polhemus	FASTSCAN
	3D Scanners	REPLICA, Model Maker, REVERSA, Re Mesh, RI Software, PROFA
	Zeiss	ZEISS T-SCAN
	Immersion	Micro Scribe 3D Micro Scribe 3DX Micro
Other systems	Immersion	Scribe 3DLX Micro Scribe 3DL
	Size Stream	Size Stream @ Home, SS20
	Zeiss	ZEISS COMET 6
	MTailor <sup>®</sup>	MTailor <sup>®</sup> mobile app
	Microsoft	Kinect
	Naked Lab	Naked Home Body Scanner

## 2.5. Body Scanning and Its application

As was previously highlighted, 3D body scanning is a relatively new technology. 3D body scanners have enabled the acquisition of anthropometric data more practical, fast, accurate, and cheaper in comparison to conventional anthropometry methods (Braganca et al., 2015). 3D body scanning systems are increasingly being used in the apparel industries (e.g. custom fit clothing, mass customization, virtual try-on, body shape categorization, and redefining sizing standard). Other than the apparel industries, 3D body scanning technology has been successfully

utilized in national anthropometric surveys, in various parts of the medical field, and in other fields like airports and even the entertainment industry (Vuruskan & Bulgun, 2011).

### **2.5.1. Body scanning in the apparel industry**

Istook and Hwang (2001) pointed out several possible motivations for the potential use of body scanning technology in the apparel industry. Body scanning technology can record linear and nonlinear measurement of human bodies in seconds. The location and description of the measurements and the image captured through body scanning can be modified in a matter of seconds. Measurements obtained through the body scanning process are more precise and highly reproducible in comparison to the conventional measuring procedure. Body scanning technology has made it possible to visualize garment fit by molding it on unique, digital human body shapes. Measurements obtained from these systems can be directly imported into various CAD systems without any human intervention which could cause error. 3D body scanning technology may also be used to produce customized fitted garments. Differences in human body size and shape can be evaluated using contour maps or polygons on images obtained from 3D body scans (Istook & Hwang, 2001).

3D body scanners capture images of an individual in a fixed posture and then create an avatar. These avatars are a scaled reflection of that individual (Ridgeway, 2018). The avatars can be used to evaluate virtual fit with the help of CAD software like Optitex and Browzwear. Hence, virtual fit can be assessed for a larger population of potential consumers than would be possible manually (Gill, 2015a). A limitation of this virtual assessment is that the fit experience can be different when the garment is actually worn by a live consumer (Gill, 2015a).

Body scanning was used by Bye and McKinney (2010) to compare a virtual scan of a subject wearing a garment and a live assessment with the same subject and garment. It was found

that there were greater stress folds and buckling in the clothed scan than the live assessment (Bye & McKinney, 2010). Other researchers have found that it was hard to locate seams on the scan of a clothed subject, thus, making it difficult to evaluate fit (Song & Ashdown, 2010). However, body scanning technology was still deemed promising for fit assessment of garments (Apeagyei, 2010; Istook, 2008; Loker, Ashdown, & Schoenfelder, 2005).

Manufacturers are utilizing technologies similar to 3D body scanning to improve online shopping experiences. Virtual try-on has been growing in popularity (Kim & Forsythe, 2008). Customers can create digital avatars representative of their bodies by inputting body measurements, facial features, hair color and body shape with the help of virtual try-on technology. Customers can view apparel on their avatars' body from different angles and try out different colors before making any purchases. Virtual try-on technology can shorten the gap between online and offline shopping experiences (Shin & Baytar, 2014). Virtual try-on can also minimize unnecessary returns of products because of fit issues as it can provide similar visual information about the product as when it is tried directly on by the consumer in store (Kim & Forsythe, 2008).

### **2.5.2. Body Scanners in National Surveys**

As previously highlighted, body scanning is an excellent method for conducting large-scale anthropometric surveys (Istook, 2008). A number of these types of surveys have been conducted world-wide, including CAESAR, SizeUK, SizeUSA, and SizeKorea. The process for conducting these studies will be highlighted in the following section.

*2.5.2.1. CAESAR.* The Civilian American and European Anthropometry Resource (CAESAR) project was one of the largest nationwide anthropometric surveys carried out so far (Istook, 2008). It included populations from the US, the Netherlands, and Italy (Robinette et al.,

1999). The survey was conducted between 1998 and early 2000. Under this project, 2,400 US and Canadian participants and 2,000 European participants were scanned and a database was created (CAESAR, 2019).

The United States Air Force carried out the survey at the Wright-Patterson Air Force Base in Ohio (Istook, 2008) . A team lead by Air Force researchers and featuring input from various companies conducted onsite, full body scanning to obtain whole-body measurements of the population between the ages of 18 to 65 years (Istook, 2008). They used a Cyberware® WB-4 whole body scanner (Istook, 2008). The total cost of CAESAR project was six million US dollars (Istook, 2008). Companies who participated in the study paid \$40,000 and companies who did not participate in the study paid as much as \$250,000 to access raw data and demographic information of the scanned population (Ponticel, 1999).

2.5.2.2. *SizeUK*. A similar study was conducted in the UK by the British government in collaboration with major apparel retailers, academics, and technology companies to develop sizing standards representative of the present British population (Istook, 2008). The survey was started in 2000 and completed in 2001. Eleven thousands people were scanned all over the UK and a total of 130 measurements were collected using a 3D whole body scanner (Istook, 2008).

2.5.2.3. *SizeUSA*. The most extensive sizing survey ever done in the US was SizeUSA, which was sponsored by the US Department of Commerce (Istook, 2008). The total cost of this survey was one million dollars (Istook, 2008). TC<sup>2</sup>® whole body scanners were employed between July 2002 and July 2003 throughout the nation. More than 10,000 subjects, representative of the US population, were scanned and their demographic and psychographic information were collected (Istook, 2008).

The interesting part of this study was that, the population was divided into target groups depending on ethnicity, weight, income level, age, and other characteristics which had never been done before (Ashdown et al., 2002). Some of the sponsors of this study included: North Carolina State University, Auburn University, Cornell University, Jockey, Sears, Dillard's, David's Bridal, the US Navy, the US Army, Target®, DuPont®, JC Penny®, Liz®, Sara Lee®, Claiborne®, Russell®, VF Corporation®, Land's End®, and Levi Strauss & Co® (Newcomb, 2004).

*2.5.2.4. SizeKorea.* The SizeKorea study was conducted between March 2003 and November 2004 (Korean Agency for Technology and Standards, 2006). Around 20,000 Koreans (up to 90 years old) were scanned (Yim Lee et al., 2007). Main goal of the study was to gather size and shape information of the Korean people and build a database of body measurements (Korean Agency for Technology and Standards, 2006).

### **2.5.3. Body Scanning in the Medical Field**

3D body scanning technology has also been used in the medical field. The moire scanner developed by Fujinon® was used to identify physical deformities in school children (Fan et al., 2004). Katashev et al. (2015) studied the use of a 3D optical scanner to monitor the progress of chest wall deformities among patients. They used 4 Aztec® scanners to monitor and map the asymmetry of chest wall movements. They found the method attractive because of its quick data capturing ability. However, the use of body scanning technology for monitoring chest wall deformity depends on the accuracy of the method. An inaccuracy of more than  $\pm 13\%$  will make the method unacceptable (Katashev et al., 2015).

3D body scanners can also have important applications in clinical environments. Clinicians depend on body mass index (BMI) for the determination of numerous health issues

related to obesity (Treleaven & Wells, 2007). Body scanning technology can replace dependency on traditional BMI calculations, which use basic height and weight. Schmitz, Gäbel, Weiss, and Schmitt (2002) reported that 3D body scanners can provide quick and accurate measurement of the human body which can be used for numerous clinical purposes such as finding more accurate BMIs of patients. Other than these, 3D body scanning technology can be used to estimate bleeding in hemophilia, diagnose lung function, and abdomen shape characteristics (Lin, Chiou, Weng, Tsai, & Liu, 2002).

3D body scanning technology can be used in skin care as well (Treleaven & Wells, 2007). Sophisticated image processing software can be used to capture wrinkles, porphyrias, and melanomas, which is the most serious and rare type of skin cancer. Medical professionals need to accurately measure burned skin area to determine the amount of fluid needed to resuscitate the patients. Previously, doctors used palms of hands to measure the burned area. Any inaccuracy in such measurement can lead to under resuscitation, which can result in possible pulmonary edema, renal failure, fluid overload, and possible death. But the development of sophisticated software along with 3D technology has reduced such risk to a great extent (Treleaven & Wells, 2007).

#### **2.5.4. Body Scanners in Other Fields**

Although 3D body scanners were primarily developed for the apparel industry, they are being used in other areas, for instance, in airports for security purposes (D'Apuzzo, 2007; Faust & Carrier, 2009). 3D body scanners have been implemented in many American and European airports as a replacement to the traditional pat down method of searching for hidden weapons on passengers (Bindahman et al., 2012). These scanners have replaced other security devices like metal and explosive detectors (Bindahman et al., 2012). The images produced by these scanners



can reveal objects that might not be a part of the body (Golden, Official, Pietra, Teufel III, & Officer, 2008). This technology can also expose sensitive medical information about the individual like mastectomies or colostomy appliances (Bindahman et al., 2012).

The Microsoft Kinect<sup>®</sup> can also be considered a body scanner, though it was not developed for obtaining body measurements (Braganca et al., 2015). It was developed as a gaming accessory. The Kinect<sup>®</sup> uses a depth camera to capture motion of the players and creates a skeleton of the individual player (Braganca et al., 2015). The Microsoft Kinect<sup>®</sup> falls under the category of structured light systems as it uses a depth camera (Shotton et al., 2011). It has been used in virtual shopping, digital signage, and in hospitals to generate images using gestures during operations (Rouse, 2011). Brownridge and Twigg (2014) used Kinect<sup>®</sup> body scanning data to produce realistic virtual human animation, which can be used for virtual fashion shows and in motion analysis. The researcher's avatars were representative of their human subjects (Brownridge & Twigg, 2014).

## **2.6. Body Scanning in Size Prediction and Mass Customization**

Body scanning technology has been used by retailers for size prediction. Companies like Levi's<sup>®</sup>, David's Bridal<sup>®</sup>, and After Hours Formal<sup>®</sup> have used 3D body scanners to obtain consumer measurements and determine if there is any garment in stock that would fit the individual customer (Istook, 2008). Body scanning technology was used by Levi's<sup>®</sup> to predict the right size custom pants for their customers. Levi's<sup>®</sup> installed their first body scanning technology in their San Francisco store in California (Istook, 2008). They allowed customers to get a body scan and used the customers' measurements to make custom pairs of jeans for each individual consumer (Lajoie, 1999). This system compared the measurements provided by the customers' body scan and the consumer's desired fit to match with the right size garment (Istook,

2008). Once the size was determined, a new custom pair of jeans were produced for that consumer.

Some other examples of body scanning technology in mass customization are as follows:

- The world's first body scanning truck was sponsored by Land's End®. This project was called "My Virtual Model Tour 2000" and continued October through December 2000. This project used an Image Twin scanner and allowed consumers to get a scan, do virtual try-on, create outfits, and determine the right size that can be purchased through the Land's End® catalog and website (Ives & Piccoli, 2003).
- A body scanner was placed at the flagship store of Brooks Brothers® on Madison Avenue in New York City in 2001 (Cohen, 2004). They allowed customers to get a free scan, which enabled them to make custom made suits at a lower price (Drake, 2007).
- Another menswear company, Benchmark®, placed body scanners in stores to scan customers in order to provide custom fit garments (Cohen, 2004).
- UK based company, Bodymetrics® offered 3D visualization and custom-made jeans at Selfridges in London. They also offered similar services at Le Bon Marche® in Paris (Istook, 2008).

3D body scanning technology has served the apparel industry greatly. This technology has allowed retailers to adopt mass customization and address fit issues (Apeageyi, 2010; Gill, 2015b). The revision of many retailer's sizing charts have also been done with the help of 3D body scanning technology (Apeageyi, 2010). Retailers are using consumer's body measurement to allow virtual try-on with the aim to facilitate online shopping experiences resulting in less clothing dissatisfaction (Ashdown et al., 2002; Kim & Forsythe, 2008). The great contribution of

3D body scanning technology in the apparel industry is that manufacturers and retailers are now catering custom made clothing to the consumers. The measurements extracted from body scanners are directly being imported to pattern making software to ensure good fit (Gill, 2015a). Retailers like Levi's® and Land's End® have adopted body scanning technology earlier (Istook & Hwang, 2001; Ives & Piccoli, 2003). However, more stores should adopt 3D body scanning technology in order to serve a wider range of consumers and ensure good clothing fit. At the same time, consumers should be educated about the potential benefit of this technology so that consumers can benefit from voluntary participation in body scanning.

## **2.7. Body Scanning and Human Subjects**

Continuous improvement is being made to ensure wider applications of this technology. In order to make successful implementation of 3D body scanning technology in the apparel industry, this technology has to be accepted by the consumers (Loker, Ashdown, Cowie, & Schoenfelder, 2004). However, consumers' perceptions about this technology across different types of 3D body scanners have not yet been explored by scholars.

Loker et al. (2004) explored consumers' interest in the application of 3D body scanning technology. They scanned and surveyed 203 women between the ages of 35-54 and 19-22. The researchers found that about 35% of those sampled were interested in the application of virtual try on technology, and 15-16% of them were interested in custom fit, size prediction, and personal shopper applications. They also found that 88% of the older sample and 77% of the younger sample were "comfortable to very comfortable" with the body scanning process. But when the participants were asked if they were willing to get a second scan, only 43% of the older sample and 24% of the younger sample agreed to be scanned once a year and 28% and 39% were willing to be scanned every six months respectively.

Ridgeway (2018) studied differences in body satisfaction before and after a body scan and exposure to the avatar created by the body scanner. The researcher found out an increase in actual-ideal self-discrepancies in both men and women after seeing avatars generated from their body scans. The research also found out that an increase in actual-ideal self-discrepancies decreased body satisfaction and mood. Thus, viewing their body scans made the participants feel more body dissatisfaction.

Another study of women by Grogan, Gill, Brownbridge, Warnock, and Armitage (2016) revealed that only 7% of participants reported increased body satisfaction after getting scanned and 34% reported body dissatisfaction. Although women were comfortable with the body scanning process, but they felt insecure and vulnerable after seeing their body scans in a printout. Hence, the researchers concluded that whole-body scanning should be undertaken with caution in the case of women with body concerns.

Lee (2013) conducted a similar study using a Me-Ality<sup>®</sup> body scanner. One of the primary purposes of the study was to explore consumer perception toward using the Me-Ality<sup>®</sup> body scanner for clothing fit. The researcher interviewed people immediately after they came out of the body scanner. The study found that almost all the customers thought that the scanner was easy to use. Workers at the Me-Ality<sup>®</sup> body scanner company reported difficulty in attracting people to get a scan. The workers assumed that the unwillingness to get a scan could result from the lack of proper knowledge about this technology.

Drake (2007) conducted a study on 517 men and women of two different age cohorts (Generation Y and Baby Boomers) to find out the factors contributing to the adoption of body scanning technology among consumers. More than 70% of the respondents reported that they would probably adopt body scanning technology in the future. The findings suggest that gender

had no significant effect on the respondents' intention to adopt body scanning technology. Likewise, age did not have a significant effect on the intention to adopt this technology. The researcher reported fun and enjoyment of the body scanning process and security in life are major factors that predicted the adoption behavior. Those who valued fun and enjoyment as well as security in life were more likely to adopt body scanning technology. On the other contrary, respondents who could be classified as late technology adopters would be more likely to wait for others to accept the technology and for more information to be revealed.

Rzepka (2011) explored female consumers' adoption behavior of 3D body scanning technology for denim jeans fitting purposes. A total of 185 participants between the ages of 18 and 35 years old responded to this researcher's survey. A total of 95% of the respondents reported fitting issues with jeans. Hedonic and utilitarian motivations were explored in terms of the adoption of body scanning technology for the purposes of improving jeans fit. The researcher found that consumers were mostly hedonically motivated to accept body scanning technology to find better fitting denim jeans. Perceived usefulness of 3D body scanning technology was found to be insignificant.

Lee et al. (2012) studied older women's attitudes toward body scanning technology in response to clothing fit. They interviewed 84 participants of at least 60 years or older. They found that most of the participants had clothing fit issues and were comfortable with the body scanning technology. Participants expressed positive attitudes toward the adoption of body scanning technology for size prediction, codesign and mass customization, virtual try-on, custom fit, and personal shopper service purposes. They also found that as age increases, interest toward the use of body scanning technology decreases.

Heuberger et al. (2010) studied older women's' comfort toward body scanning technology for improving quality of life compared to younger women. They surveyed 122 women (66 women between the ages of 18-21 years old and 66 older women between the ages of 51-87 years) of two age groups. The researchers found that even though both groups were comfortable with the scanning process, younger women were significantly less comfortable with the preparation for the scan. Moreover, the younger women group had higher body image dissatisfaction than the older group. Additionally, a higher BMI negatively affected body satisfaction regardless of age.

Fiore et al. (2003) studied psychographic variables that are major predictors of the willingness toward body scanning. They introduced body scanning to participants as an instrument providing an exciting experience along with fit improvement. They conducted the study among 521 students from the East coast, West coast, north central, southeast and southwest parts of the US. The researchers found that both the exciting experience from the use of body scanning technology and the usefulness to find better fitting clothing were significant motivations for participants to try this technology. The researchers reported that individuals with high EA (Experimenting with Appearance) will use body scanning for both an exciting experience and for finding better fitting clothing. On the other hand, EI (Enhancement of Individuality) individuals were willing to use body scanning technology for clothing fit purposes only.

Al-Mousa (2011) explored the adoption of body scanning technology among young consumers (18-21 years old) in Saudi Arabia. The researcher found out that consumers there were overwhelmingly interested in trying body scanning technology to experience it and to find better fitting clothing. Consumers who were highly involved with fashion were more likely to

adopt this technology. The researcher also reported that religiosity, modesty, and social security had no effect on the interest to try body scanning.

## **2.8. Theoretical Framework**

The Technology Acceptance Model (TAM) was chosen as the theoretical framework for this research. TAM is capable of illustrating and predicting consumers' behavioral intentions and actual behavior regarding acceptance of new technologies (Davis, 1989). It was originally developed to explain consumers' intention to adopt information technologies (Davis, 1989). TAM has since been applied to predict consumers' behavioral intentions regarding the use of different computer applications (word processor, spreadsheet, email, moodle etc.), computer games acceptance, and even body scanning technology (Davis, 1989; Davis, Bagozzi, & Warshaw, 1992; Sánchez & Hueros, 2010; Wang & Goh, 2017). TAM claims that consumers' intention to use any new system depends on consumers' internal belief and attitude toward the system (Davis, 1989). TAM is mainly used to explain the underlying determinants of behavior toward technology (Davis, 1989).

Perceived usefulness and perceived ease of use are two major predictors of technology acceptance (Davis, 1989). According to Davis (1989), intention to adopt a program or a technology depends on the belief that the adoption will help the user to perform some sort of task better (perceived usefulness). Davis (1989) defined perceived usefulness as “the degree to which a person believes that using a particular system would enhance his or her job performance” (p. 320).

However, even if the technology seemed to help consumers in performing their job better, consumers may not adopt the program or technology if it is not easy to use. Consumers will not be willing to try out something which is hard or inconvenient to use. This is called

perceived ease of use (Davis, 1989). Perceived ease of use is specifically defined as “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320).

Furthermore, TAM has been used with studies related to apparel and consumer behavior. Rzepka (2011) applied TAM into practice to explore consumers’ hedonic and utilitarian motivations to get better fitted jeans toward the adoption behavior of body scanning technology. The study reported that consumers are mostly hedonically motivated to adopt body scanning technology and that perceived usefulness were insignificant. Other researchers included TAM in exploring adoption behavior of virtual try-on technology in an online shopping environment (Kim & Forsythe, 2008). This study reported a positive effect of perceived usefulness on the adoption of virtual try-on technology by consumers.

## **2.9. Hypothesis Development**

As described earlier, ample research has been conducted regarding consumers’ perceptions and adoption of 3D body scanning as a relatively new technology. However, all the research that has been done so far used one of the light-based or laser-based technologies to gauge consumers’ perceptions and adoption behaviors. To the researcher’s knowledge, no study had compared consumers’ perceptions and willingness to adopt across different types of body scanning technologies available in the market. As manufacturers are constantly improving body scanning to make this technology more widely available and to improve consumers’ experience, it was important to know consumers’ acceptance behavior regarding the latest technologies when compared to existing technologies in the market. Therefore, this research studied consumers’ preferred body scanning technology among conventional 3D body scanning (e.g. Size Stream SS20), mobile-based scanning (e.g. MTailor<sup>®</sup>), and scan suit-based scanning (e.g. Size Stream @



Home) technologies. This study also explored how preferences differed between men and women regarding 3D body scanning technology.

The primary purpose of body scanning technology in the apparel industry is to acquire accurate measurements to improve clothing fit (Apeagyei, 2010; D'Apuzzo, 2007; Istook, 2008). While the purpose is the same across different types of body scanners, the working procedure of the scanners can vary. When considering the Technology Acceptance Model, researchers found perceived usefulness to be a strong predictor of technology acceptance (Rogers, 1995; Venkatraman & Price, 1990). Kim and Forsythe (2008) found perceived usefulness to have a positive effect on the adoption behavior toward virtual try-on technology. However, when considering the three types of scanners under investigation for this research, all three were capable of producing similar types of data. Thus:

H1: There will not be a significant difference in the perceived usefulness of the three types of body scanning systems.

Mobile phones are widely available and can perform a wide range of activities. The availability of mobile phones is probably why manufacturers have developed mobile based applications to make the 3D body scanning and measurement extraction procedure easier and more convenient (MTailor, 2019). According to TAM, perceived ease of use was a major predictor of technology adoption behavior (Davis, 1989; Venkatraman & Price, 1990). Mobile based scanners made body scanning easier and more convenient for consumers. With the help of mobile phones, people could get a scan at home. Thus, it was hypothesized the:

H2: The mobile-based scanner will have higher perceived ease of use than the traditional body scanner.

As described earlier, the new suit-based body scanner by Size Stream® (Size Stream @ Home®) could be used at home or in the gym to track body shape related changes during workout programs. The company also claimed that Size Stream @ Home® could determine the distribution of fat in the human body and extract accurate body measurements (Size Stream, 2019). The accuracy of measurements is highly important for purposes like health management (Treleaven & Wells, 2007). Researchers found that perceived ease of use had a strong positive effect on technology adoption (Darden & Lusch, 1983; Davis, 1989; Venkatraman & Price, 1990). Size Stream @ Home body scanner can be used at home or anywhere without the help of a professional. Moreover, consumers do not need to be briefly dressed like in case of the traditional body scanner to get scanned. In general, the suit-based body scanner appears to be easier and more convenient than the traditional body scanner. Therefore, it was hypothesized:

H3: The suit-based scanner will have higher perceived ease of use than the traditional body scanner.

Researchers suggested that consumers were concerned about the tight clothing requirements of body scanning technology (Heuberger et al., 2010). Heuberger et al. (2010) reported that young women were not comfortable with the clothing preparation process for getting a body scan. The researchers did not study concerns regarding the preparation process among men. However, as the suit-based scanner required consumers to wear a tight-fitting scan suit and be photographed by another individual, it may have been that women were particularly uncomfortable using this model. It was hypothesized that:

H4: The suit-based scanner will have a lower perceived ease of use for women than men.

Research suggested that women were more concerned about body shape than men (Grogan & Richards, 2002). Other researchers proposed that women also had higher

technological anxieties than men (Hoffman & Novak, 1996; Venkatesh & Morris, 2000). Thus, as body scanners capture body shapes and rely on technology, the choice of a certain type of body scanner may be different between men and women. Hence it was hypothesized:

H5: There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology.

## **Chapter 3. Methods and Procedures**

This chapter contains the rationale as well as the method used for this study. The overall purpose of this research was to find out consumers' preferred type of body scanner using the Technology Acceptance Model (Davis, 1989) as a framework. This study further explored differences in preferred type of body scanning technology between men and women. Hypotheses were developed to further investigate this topic. The hypotheses for this this research were:

H1: There will not be a significant difference in the perceived usefulness of the three types of body scanning systems.

H2: The mobile-based scanner will have higher perceived ease of use than the traditional body scanner.

H3: The suit-based scanner will have higher perceived ease of use than the traditional body scanner.

H4: The suit-based scanner will have a lower perceived ease of use for women than men.

H5: There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology.

Creswel (2017) argued that a quantitative study is appropriate for testing theories using hypotheses because quantitative studies established relationships among variables. Therefore, a quantitative research design was ultimately chosen to understand consumers' preferred body scanning technology.

### **3.1. Institutional Review Board Approval**

Prior to beginning the research, approval was obtained from the Institutional Review Board (IRB) of Louisiana State University (see Appendix B). Original approval was received via email. Documents containing the survey invitation and the original survey were submitted for the

approval process. There was no foreseeable risk to the participants of this research. All the participants were assured of the anonymity of data collected through their voluntary participation.

Participants for this research were required to be at least 18 years of age or older because most of the previous studies regarding body scanning technology included participants of age 18 years and older (Apeagyei, 2010; Bourgeois et al., 2017; Heuberger et al., 2010; Loker et al., 2004; Ridgeway, 2018; Shin & Baytar, 2014). Participants were also required to reside in the United States to enable the researcher to more easily compare across consumers who would be familiar with similar shopping environments. Additionally, participants living only in the US were recruited because 3D body scanning technologies may not be widely available in other countries. These were the only two restrictions placed on the potential participants.

### **3.2. Participants Recruitment**

Recruitment of participants progressed in three major ways, via personal emails, social media platform postings, and through a snowball sampling technique. A self-administered survey was generated in Qualtrics<sup>®</sup>. Once the survey was created, a link to the survey was generated for distributing the survey. The survey link was dispersed to potential participants directly, through personal emails to faculty, staffs, friends and family members. The survey link was also distributed through postings on numerous social media platforms. The social media platforms included Facebook<sup>®</sup>, Twitter<sup>®</sup>, Instagram<sup>®</sup>, and LinkedIn<sup>®</sup>. The researcher placed the link on pages/forums such as Facebook<sup>®</sup> groups, Facebook<sup>®</sup> posts, Twitter<sup>®</sup> posts, Instagram<sup>®</sup> feeds, and in personal messages in LinkedIn<sup>®</sup>.

Other platforms like Amazon<sup>®</sup> Mechanical Turk (a marketplace referred as MTurk<sup>®</sup>, which can be found at [www.mturk.com](http://www.mturk.com)) were not used to collect data for several reasons.

MTurk® represents participants of a certain age group and income level (Antoun, Zhang, Conrad, & Schober, 2016). Moreover, these participants receive a small payment for participating in surveys, which may cause them to take less care with the survey (Sheehan, 2018). Besides, there are concerns among researchers about the quality and reliability of the data obtained through MTurk® (Rouse, 2015). Thus, it was deemed appropriate to use the recruitment methods outlined above only for the purpose of this study because these social platforms help to reach participants of wide demographic even though the response rate is relatively low compared to MTurk® (Antoun et al., 2016; Casler, Bickel, & Hackett, 2013).

Snowball sampling was also employed for this research. Snowball or chain referral sampling is widely applicable in sociological research (Biernacki & Waldorf, 1981). In snowball sampling, primary participants invite others within their social network whom they think might be interested in the topic. One great advantage of snowball sampling is that it yields a larger sample of participants with characteristics of interest to the researcher. Snowball sampling is especially helpful when exploring sensitive issues and requires inside knowledge of participants who know others with the similar issues (Biernacki & Waldorf, 1981). Thus, all the participants were asked to distribute the survey link to other potential participants they knew who might be willing to participate in the survey.

A target sample of 500 participants of different age groups (18 years old and above), living in the US were sought to participate in the study. Since an online survey design was ultimately chosen, a target population of 500 participants were deemed reasonable. Researchers have suggested that the response rate of online surveys vary between 40-50% (Guo, Kopec, Cibere, Li, & Goldsmith, 2016). Hence, 200-250 participants were anticipated and would produce reasonable data for analysis (MacCallum, Widaman, Zhang, & Hong, 1999).

### **3.3. Survey Design**

A survey was constructed to collect the necessary data for investigating the purpose statement and testing the hypotheses. Surveys are well established in behavioral research because surveys can be designed to measure and quantify variables of interest and the procedure decreases time and cost (Fricker & Schonlau, 2002; Wright, 2005). The survey was designed using Qualtrics® software which allows for online data collection. Online surveys were found to be efficient in gathering large volume of data that could be examined quantitatively (Creswel, 2017).

The survey was purposely designed to collect the necessary data to test the hypotheses. Consent of participants were obtained before they could access the questionnaire. A preexisting survey instrument related to the TAM (Davis, 1989) was modified to fit into the survey for body scanning technology. For testing gender effects on preferred technology, relevant demographic questions were included in the survey. Required demographic information were adopted from existing research (Lee et al., 2012).

Section A was a disclaimer about the nature of the survey and obtained consent regarding participation in the survey (see Appendix A). Section B explained the three types of body scanners (traditional scanners, mobile-based scanners, and suit-based scanners) that were of specific interest to the study. Participants were presented with a single body scanning technology at a time. Each body scanning technology contained an image and a brief description of specific scanning procedures and clothing requirements. Possible uses of 3D body scanning were explained to help the participants understand the overall process and use of the 3D body scanning technology.

Following the overview of the 3D body scanning technology, participants were asked a series of Likert-type questions related to their willingness to use and perceived usefulness of that body scanner (Davis, 1989). The Likert-type survey questions were adopted from the original Technology Acceptance Model of Davis (1989) and modified to fit in the specific study. A 7-point Likert scale was used to measure each construct. Likert-type scales are often used in behavioral studies (Al-Mousa, 2011; Croasmun & Ostrom, 2011; Drake, 2007; Heuberger et al., 2010). Likert scales are used to effectively evaluate and quantify consumers' attitudes (Croasmun & Ostrom, 2011). A total of 17 Likert-type questions were asked related to each of the 3D body scanning technologies. Additional open-ended questions were also added to gather more information about the participant's views on the various 3D body scanning technologies. These questions included: consumers' thoughts about the specific type of 3D body scanning technology and how much they would be willing to pay for a scan.

Once the participant finished the questions related to the first 3D body scanning technology, they were presented with the second type of 3D body scanning technology followed by the same series of Likert-type questions related to the technology. Ultimately, the participants were shown the three types of 3D body scanning technologies and asked to answer the same Likert-type (1-7, strongly disagree – strongly agree) survey questions and open-ended questions for each body scanner. The researcher choose to randomize the order in which each participant was shown the three types of 3D body scanners in an effort to keep out bias from survey fatigue (Porter, Whitcomb, & Weitzer, 2004).

Finally, demographic data of the participants were collected in Section C of the survey. Demographic information included age, gender, ethnicity, educational background, income level, gym utilization, and whether the participant was interested in custom fit clothing. The survey



participants were thanked on the final page and asked to distribute the survey link to anyone who might be interested in participating as part of the snowball sampling technique (Biernacki & Waldorf, 1981).

### **3.4. Survey Questions and Hypothesis Testing**

Various survey questions were designed to answer particular hypotheses and data was collected to test those hypotheses. For instance:

H1: There will not be a significant difference in the perceived usefulness of the three types of body scanning systems. This was answered by data from questions 1 through 10.

H2: The mobile-based scanner will have higher perceived ease of use than the traditional body scanner. This was answered by data from questions 11 through 16 between the mobile-based scanner and conventional scanner.

H3: The suit-based scanner will have higher perceived ease of use than the traditional body scanner. This was answered by comparing data from questions 1 through 10 between the suit-based scanner and conventional scanner.

H4: The suit-based scanner will have a lower perceived ease of use for women than men. This was answered by data from questions 11 through 16 regarding gender.

H5: There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology. This was answered by data from question 17.

### **3.5. Pretesting, Validity, and Reliability**

Prior to data collection, content validity was assessed to evaluate the relevance of individual items (Creswel, 2017). Initial items included in the survey were identified through an extensive review of literature. The final items were adopted from a study that utilized the TAM

to investigate consumers' perception on 'perceived usefulness' and 'perceived ease of use' on the adoption behavior of computer technology (Davis, 1989). Next, two experts in the area of social science reviewed the survey design and hypotheses under investigation. Necessary changes were made based on their opinions.

Validity and reliability were also enhanced through pretesting the survey. Pretesting helps researchers to identify understandability of questions, ambiguity, and prejudice (Pedhazur & Schmelkin, 2013). Around 25-50 participants is considered to be enough for pre-testing a survey like the one created for this research (Godey et al., 2013). Thus, a convenience sample of 30 undergraduate students participated in the pretesting of the survey. A Cronbach alpha was generated for testing reliability. Data analysis was done for the pretest and changes were made prior to launching the final survey.

### **3.6. Data Analysis**

Data was downloaded from Qualtrics® in Excel® and put into a format required by the software for data analysis. The first step was cleaning the raw data. All incomplete and biased responses were excluded from further processing. Bias responses were identified by examining whether the participants selected the same level of the Likert scale throughout the entire survey. Missing data was excluded as the researcher had enough data for further analysis. SAS® software was used for data analysis purposes. Descriptive statistics like, minimum, maximum, mean, frequency, percentage, and standard deviation were run first.

Normality test was performed to check whether the data was collected from a normally distributed population. Skewness and kurtosis were performed to ensure that the data was collected from a normally distributed population. Normality among data is important for performing factor analysis (Samani, 2016).

Different statistical analysis was performed using SAS<sup>®</sup>9.4 software to test different hypotheses. The following tests were performed to help investigate each hypothesis:

**Hypotheses One** was tested using mixed procedure. The mixed procedure is used to estimate maximum likelihood and allows the flexibility of modeling means, variances, and covariances (SAS, 2020). So, the researcher used mixed procedure to compare means of the three groups on dependent sample.

**Hypotheses Two and Three** were tested using a one sample paired t-test. One sample t-test is used to test differences between the means of two treatment levels of the same sample group (StatisticsSolutions, 2019). So, the researcher used one sample paired t-test to test differences between means of two treatment levels (two types of body scanners).

**Hypotheses Four and Five** was tested using one-tailed two sample t-test and two-tailed two sample t-test respectively. A t-test is used to compare differences between groups. A t-test can be one-tailed or two-tailed. Two-tailed t-test is used to determine differences between groups, whereas one-tailed t-test is used to check if one group has a higher score than the other (StatisticsSolutions, 2019). So, the researcher used one-tailed t-test to determine if suit-based scanner (treatment) will have lower perceived ease of use for women than men and two-tailed t-test to determine if the preference to adopt any of the three body scanners differs significantly between men and women.

## **Chapter 4. Results and Discussion**

The purpose of this research was to explore consumers' preferred type of body scanning technology among three different types of body scanners using the Technology Acceptance Model (Davis, 1989). The three types of body scanning technology were a conventional body scanner that works on infrared technology (Size Stream<sup>®</sup> SS20), a suit-based scanner that uses a scanning suit and mobile camera (Size Stream @ Home<sup>®</sup>), and a mobile-based scanner (MTailor<sup>®</sup>). Five hypotheses were developed and analyzed using SAS<sup>®</sup> 9.4 software. The hypotheses that were developed are as follows:

H1: There will not be a significant difference in the perceived usefulness of the three types of body scanning systems.

H2: The mobile-based scanner will have higher perceived ease of use than the traditional body scanner.

H3: The suit-based scanner will have higher perceived ease of use than the traditional body scanner.

H4: The suit-based scanner will have a lower perceived ease of use for women than men.

H5: There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology.

This chapter presents an overview of data screening, sample characteristics, and demographics.

The hypotheses testing results will also be evaluated and discussed.

### **4.1. Data Screening**

Recruitment for the research began following IRB approval (see Appendix B). The survey link was posted on Facebook<sup>®</sup>, Instagram<sup>®</sup>, Twitter<sup>®</sup>, and LinkedIn<sup>®</sup>. It was also emailed to acquaintances of the researcher. Finally, participants were asked to forward the

survey to others who might be interested in contributing in a snowball sampling technique. Data collection took place from mid-December 2019 to the end of January 2020.

A total of 382 participants opened the survey and 254 of them completed the survey, for a completion rate of 66.49%. Data quality was tested and cleaned using standard data screening and cleaning procedures prior to data analysis. All incomplete and biased responses were excluded from further processing. Responses with missing values were also omitted from analysis. Among the 254 complete responses, 34 of the responses were excluded from further analysis because of missing data and/or response bias. A response bias occurs when the respondents select the same Likert choice throughout the entire survey (Stephanie, 2015). Finally, there were 220 valid responses, which were analyzed using SAS<sup>®</sup> 9.4 software.

Table 4.1 contains the mean, median, minimum, and maximum values of the survey responses. Skewness and kurtosis values indicate the degree of normality of the data (West, Finch, & Curran, 1995). According to West et al. (1995), if the absolute values of skewness and kurtosis do not exceed 2 and 7 respectively, then that indicates normally distributed data. The current data set did not show any such indication. Hence, it was concluded that the final data were normally distributed.

Table 4.1. Data Quality Report (n=220)

Scanner Type	Survey Items	Mean	Median	Min.	Max.	Standard Deviation	Skewness	Kurtosis
Scanner A	Q1	5.86	6	1	7	1.27	-1.86	3.99
	Q2	5.83	6	1	7	1.07	-1.73	5.19
	Q3	5.74	6	1	7	1.11	-1.61	3.73
	Q4	5.76	6	1	7	1.12	-1.56	3.73
	Q5	5.54	6	1	7	1.20	-1.25	2.05
	Q6	5.87	6	1	7	1.08	-1.65	4.21
	Q7	5.68	6	1	7	1.21	-1.33	2.22
	Q8	5.64	6	1	7	1.17	-1.35	2.39
	Q9	5.70	6	1	7	1.15	-1.57	3.40
	Q10	5.73	6	1	7	1.15	-1.59	3.46
	Q11	5.32	6	1	7	1.40	-0.90	0.26
	Q12	5.24	6	1	7	1.33	-0.79	0.17
	Q13	5.63	6	1	7	1.12	-1.18	2.14
	Q14	5.03	5	1	7	1.46	-0.73	-0.06
	Q15	5.31	6	1	7	1.30	-0.92	0.57
	Q16	5.32	6	1	7	1.34	-0.88	0.34
	Q17	5.24	6	1	7	1.48	-0.93	0.35
Scanner B	Q1	5.31	6	1	7	1.47	-1.03	0.29
	Q2	5.46	6	2	7	1.33	-1.09	0.68
	Q3	5.39	6	1	7	1.29	-1.08	0.89
	Q4	5.45	6	1	7	1.32	-1.20	1.18
	Q5	5.32	6	1	7	1.34	-0.98	0.38
	Q6	5.51	6	1	7	1.25	-1.16	1.40
	Q7	5.42	6	1	7	1.27	-1.20	1.51
	Q8	5.39	6	1	7	1.28	-1.05	0.86
	Q9	5.40	6	1	7	1.32	-1.00	0.70
	Q10	5.37	6	1	7	1.30	-0.96	0.55
	Q11	5.20	5	1	7	1.36	-0.86	0.47
	Q12	5.09	5	1	7	1.36	-0.70	0.01
	Q13	5.43	6	1	7	1.19	-1.17	1.68
	Q14	5.02	5	1	7	1.41	-0.81	0.20
	Q15	5.31	6	1	7	1.24	-1.02	0.97
	Q16	5.12	5	1	7	1.38	-0.89	0.29
	Q17	4.88	5	1	7	1.59	-0.79	-0.25
Scanner C	Q1	5.68	6	1	7	1.28	-1.65	2.99
	Q2	4.93	5	1	7	1.45	-0.73	-0.12
	Q3	4.89	5	1	7	1.47	-0.63	-0.42

(table cont'd)

Scanner Type	Survey Items	Mean	Median	Min.	Max.	Standard Deviation	Skewness	Kurtosis
Scanner C	Q4	5.16	5	1	7	1.33	-1.04	0.79
	Q5	4.99	5	1	7	1.35	-0.78	0.18
	Q6	4.87	5	1	7	1.44	-0.60	-0.48
	Q7	5.10	5	1	7	1.46	-0.93	0.38
	Q8	5.14	5	1	7	1.32	-0.85	0.27
	Q9	5.07	5	1	7	1.45	-1.01	0.39
	Q10	5.06	5	1	7	1.33	-0.77	0.06
	Q11	5.64	6	1	7	1.17	-1.11	1.19
	Q12	5.51	6	1	7	1.31	-1.05	0.92
	Q13	5.71	6	1	7	1.20	-1.28	2.03
	Q14	5.45	6	1	7	1.33	-1.00	0.71
	Q15	5.57	6	1	7	1.17	-1.04	1.24
	Q16	5.71	6	1	7	1.21	-1.40	2.38
	Q17	5.71	6	1	7	1.21	-1.40	2.38

## 4.2. Sample Demographics

Demographic characteristics of the participants are summarized in Table 4.2. Results indicated that 77.27% (n= 170) of the participants are female, 20.45% (n= 45) are male, and 2.27% (n= 5) are either gender variant or did not prefer to answer. The higher percentage of female participants were consistent with previous research suggesting that young females are more fashion concerned than males (Al-Mousa, 2011; Loker et al., 2004).

Table 4.2. Demographic Characteristics of the Sample (n=220)

Demographic	Variable	No. of Participant	Percentage
Gender	Male	45	20.45%
	Female	170	77.27%
	Other	5	2.27%
Age	18 to 25 Years	168	76.36%
	26 to 35 Years	49	22.27%
	36 to 45 Years	1	0.45%
	46 to 55 Years	-	-
	56 to 65 Years	1	0.45%
	65 and Older	1	0.45%

The majority of the participants were within the age range of 18-25 years old (n= 168; 76.36%) and 26-35 years old (n= 49; 22.27%). The high number of younger participants was due to the recruitment of undergraduate students and represented a weakness in the sample. More than 70% (n= 220) of the participants indicated that they had either used or were interested in custom fitted apparel products. The interest in custom fitted apparel among the participants could have influenced their final choice of body scanning technology. One researcher suggested that consumers were primarily interested in body scanning technology to find right fitting apparel products (Lee, 2013). Whereas another researcher found that consumers were hedonically motivated to use body scanners to have fun or someone else asked them to try the technology (Rzepka, 2011).

The survey also recorded whether the participants were frequent gym users. Demographic data indicated that 44.54% (n= 220) of the participants were frequent gym users. It is possible that the participants who were gym goers would be particularly interested in body scanning technologies which could help to monitor changes in the body for fitness purposes (traditional scanner and scan-suit scanner).

Participant responses to the open-ended questions were then summarized. Participant responses to the question “How much would you be willing to pay for a single body scan using this scanner?” ranged from free to \$3,000 for all three types of scanners. Some of the participants were willing to pay only if they could find the right fitted apparel products by using the body scan. Whereas others expected free services from apparel brands at shopping malls. Previous research suggested that consumers are willing to pay separately for body scans to help them find better fitted clothing. The amount they were willing to pay ranged from \$10 to \$25 (Loker, Ashdown, & Carnrite, 2008).



Participants also responded to the question “Do you have any other thoughts or opinions about this body scanner?” Participants reported that the traditional body scanner was the most reliable body scanner to find apparel products with the correct fit. At the same time, they expressed concerns regarding health issues, clothing requirement, skepticism about the accuracy of the measurements, and inconvenience of accessibility which are quite consistent with previous research. Research suggested that even though participants were comfortable with the body scan, they were uncomfortable with the scanning preparation (Heuberger et al., 2010; Loker et al., 2008). Participants’ concerns regarding the health concerns are appeared to be valid. Accardo and Chaudhry (2014) suggested that the whole-body scanners at the airports have raised concerns among the passengers because of the radiation emitted from the scanners. However, some other participants reported that the scanners may have trouble with pinpointing measurement location.

Participants mostly felt the suit-based scanner was easy to use. Previous research suggested that consumers were uncomfortable with the scanning procedure of the traditional body scanners (Heuberger et al., 2010). It is probable that the reason participants found suit-based scanners were easier to use for this reason. However, some participants expressed concerns about the suit size, for instance if it was one-size-fits-all or if the suit comes in individual sizes. Some participants also mentioned that getting help from someone else while taking the scan was inconvenient.

Participants considered the mobile-based scanner to be easy and convenient. They expressed concerns about the privacy of the data which is consistent with prior research. Bindahman et al. (2012) reported that 3D body scanners have raised privacy concerns and ethical issues among professionals, researchers, and general population as these machines can accurately

generate three-dimensional images of the human body. Apart from this, some of the participants thought that the measurements might not be as accurate when compared to the other types of body scanners. Some other participants expressed dissatisfaction for not being able to use the measurements for shopping from other brands.

In response to the question, “Considering the three body scanners which would you be least likely to use?” 27.27% of the participants responded that they would be least likely to use traditional body scanner (Body Scanner A). Inaccessibility, health concerns, inconvenience, and clothing requirements were identified as the reasons for traditional body scanner to be the least favorite among the participants.

For the suit-based scanner (Body scanner B), 41.82% of the participants indicated that it was their least favorite scanner. The requirement of a second person, complicated nature of the scan, and changing into a scanning suit were reported to be the underlying reasons for the suit-based scanner to be their least favorite choice.

The mobile-based scanner (Body Scanner C) was least favorite among 30.91% of the participants. Uncertainty of the accuracy of measurements and not being able to use the measurements for shopping with other brands were identified as the underlying issues with this scanner.

In response to the question, “Considering the three body scanners which would you be most likely to use?” 47.73% of the participants indicated that the traditional body scanner (Body scanner A) was their favorite type of body scanner. They reported that the professional look of the scanner and ability to get accurate measurements made Body Scanner A their favorite type of scanner.

For the suit-based scanner (Body Scanner B), only 16.36% of the participants reported it as their favorite scanner. Reliable measurements, easy to use, and flexibility were identified as reasons for choosing the suit-based scanner.

The mobile-based body scanner (Body Scanner C) was chosen as the most favorite type of scanner by 35.91% of the participants. Easy to use, accessibility, flexibility, and convenience to use at any time were reported to be the reasons behind the choice.

### 4.3. Hypothesis Testing

This study was conducted using the Technology Acceptance Model (Davis, 1989) to find out consumers' preferred body scanning technology. Five hypotheses were developed under the TAM (Davis, 1989). The TAM (Davis, 1989) was previously used to determine consumers' hedonic and utilitarian motivation to try body scanning technologies to find better fitted jeans (Rzepka, 2011). Data analysis suggested that among the five hypotheses, only two were fully supported and hypothesis five was partially supported. A brief description of each of the outcomes and discussion (see Table 4.3: A Summary of Hypotheses Testing Results) is provided in the following section.

Table 4.3. A Summary of Hypotheses Testing Results

Hypotheses		Results
H1	There will not be a significant difference in the perceived usefulness of the three types of body scanning systems.	Not Supported
H2	The mobile-based scanner will have higher perceived ease of use than the traditional body scanner.	Supported
H3	The suit-based scanner will have higher perceived ease of use than the traditional body scanner.	Not Supported
H4	The suit-based scanner will have a lower perceived ease of use for women than men.	Supported
H5	There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology.	Partially Supported

H1: There will not be a significant difference in the perceived usefulness of the three types of body scanning systems. **Not supported.**

In this study, the perceived usefulness construct from the TAM (Davis, 1989) was measured using ten items (Question 1 - 10) that covered time, convenience, efficiency, usefulness, and accuracy of the body scanners. The perceived usefulness was calculated for each of the three types of body scanning technology. Data analysis showed that participants' perceived usefulness varied across the body scanner types (see Table 4.4 Perceived Usefulness of Body Scanners). Data analysis indicated that the participants' perceptions of perceived usefulness for the three types of body scanners in the study differed significantly (P-value <0.001). Hence, the developed hypothesis was not supported by the data.

Table 4.4. Perceived Usefulness of Body Scanners

Type 3 Tests of Fixed Effects				
Effect	Number of Degrees of Freedom	Denominator Degrees of Freedom	F Value	Probability > F
Body Scanner Type	2	438	33.96	<.0001**

Note: \*\* indicates body scanner type to be a significant source of difference at 95% confidence interval.

Davis (1989) suggested that perceived usefulness is an important predictor toward behavioral intention to use any technology. Whenever consumers possess a positive notion of perceived usefulness, they tend to use the technology (Davis, 1989). Of the three scanner types tested, the participants had different level of perceived usefulness for the different types of scanners. Given the written feedback from the participants, it is clear that many felt the traditional scanner was the most useful because it could provide the most accurate data. Additionally, they felt the mobile-based scanner had less perceived usefulness because the measurements could not be used for shopping with other brands.

H2: The mobile-based scanner will have higher perceived ease of use than the traditional body scanner. **Supported.**

In this study, the perceived ease of use construct (Davis, 1989) was measured using six items that covered easiness, clarity of understanding, flexibility, and skillfulness of the body scanners (Questions 11-16). The perceived ease of use was calculated for each of the three types of body scanning technology (see Table 4.5 One-Sample t-test Result (C-A)). Data analysis indicated that consumers' perceived ease of use was higher for the mobile-based scanner (Body Scanner C) than the traditional body scanner (Body Scanner A). Data analysis indicated that the participants felt the mobile-based scanner was easier and more convenient to use than the traditional scanner (P-value 0.001). Hence, hypothesis two was supported by the data.

Table 4.5. One-Sample t-test Result (C-A)

Difference: Body Scanner C – Body Scanner A		
Degree of Freedom	t Value	Probability > t
219	3.68	0.0001**

Note: \*\* indicates significant difference at 95% confidence interval.

Perceived ease of use is an important predictor of behavioral intention to use any technology (Davis, 1989). When consumers perceive that the adoption of a technology is easy and it is helpful to be skilled in using the technology, then they will tend to adopt that technology (Davis, 1989). As most contemporary consumers are familiar with using mobile phones, it was not surprising that they would feel the mobile based scanner was the easiest to use (Pivetta, Harkin, Billieux, Kanjo, & Kuss, 2019). Additionally, the mobile-based scanner could be done in any location making it easier to use than the traditional body scanner which had to be visited in specific locations.

H3: The suit-based scanner will have higher perceived ease of use than the traditional body scanner. **Not supported.**

Hypothesis three was developed to test if consumers' perceived ease of use for the suit-based body scanner (Body Scanner B) was higher than the traditional body scanner (Body Scanner A). Data analysis (see Table 4.6 One-Sample t-test Result (B-A)) showed that the participants' perceptions of ease of use for the suit-based scanner and the traditional scanner did not differ significantly (P-value 1.0). Hence, hypothesis three was not supported by the data.

Table 4.6. One-Sample t-test Result (B-A)

Difference: Body Scanner B – Body Scanner A		
Degree of Freedom	t Value	Probability > t
219	1.27	0.1036**

Note: \*\* indicates non-significant difference at 95% confidence interval.

It can be assumed that the perceived ease of use for the traditional body scanner and suit-based body scanner did not vary significantly because of the inconvenience of inaccessibility or the high cost of acquisition of the scanners. For both scanners, participants must either purchase or locate the scanners to get a scan.

H4: The suit-based scanner will have a lower perceived ease of use for women than men.

### **Supported.**

Hypothesis four was developed to test the difference in perceived ease of use for the suit-based scanner (Body Scanner B) between men and women. For this hypothesis, only the responses for self-identified male and female participants were utilized as there were very few individuals identified as other genders or preferred not to answer. Data analysis indicated that the perceived ease of use for the suit-based scanner was significantly different between the genders (see Table 4.7: Perceived Ease of Use of the Suit-Based Scanner Mean Values by Gender)

Table 4.7. Perceived Ease of Use of the Suit-Based Scanner Mean Values by Gender

Gender	Mean
M	33.2667
W	30.6529

The perceived ease of use (See Table 4.8: Two-Sample t-test Result) for suit-based scanner was statistically different for men and women (P-value >0.0118). The calculated means suggested that men (m = 45) found the suit-based scanner to be easier to use than women (w = 170). Hence, hypothesis four was supported by the data.

Table 4.8. Two-Sample t-test Result

Method	Variances	Degree of Freedom	t Value	Probability > t
Pooled	Equal	213	2.28	0.0118**

Note: \*\* indicates significant difference at 95% confidence interval.

It was no surprise that men found suit-based body scanning technology easier to use, as women found to have more body dissatisfaction and anxieties than men (Venkatesh & Morris, 2000). These anxieties and dissatisfactions may have influenced some women to feel uncomfortable when wearing the tight-fitting suit in front of another person, which are requirements for using the suit-based scanner. Additionally, some researchers have found that women have higher technology anxieties than men (Hoffman & Novak, 1996; Venkatesh & Morris, 2000) meaning they may be more likely-to avoid using technology like the mobile-based scanner app.

H5: There will be a significant difference in preferences between men and women in adopting a particular type of body scanning technology. **Partially Supported.**

Hypothesis five was developed to test whether the preference for adopting any particular type of body scanner differed between men and women. Participants were asked to consider the three body scanners and answer which they would be most likely to use. Men were most likely to use the mobile-based body scanner (55.56%, m=45). Women were most likely to use traditional body scanner (51.18%, w=170).

Next, a two-sample t-test was performed to determine if there were differences in preference for body scanning technology types between men and women. Data analysis indicated that the preference for adopting the traditional body scanner (P-value> 0.8774) and the suit-based body scanner (P-value> 0.0937) did not differ significantly between men and women (see Table

4.9: P-value for Traditional Body Scanner and Table 4.10: P-value for Suit-Based Body Scanner).

Table 4.9. P-value for Traditional Body Scanner (Body Scanner A)

Method	Variances	Degree of Freedom	t Value	Probability > t
Pooled	Equal	213	0.15	0.8774**

Note: \*\* indicates non-significant difference at 95% confidence interval.

Table 4.10. P-value for Suit-Based Body Scanner (Body Scanner B)

Method	Variances	Degree of Freedom	t Value	Probability > t
Pooled	Equal	213	1.68	0.0937**

Note: \*\* indicates non-significant difference at 95% confidence interval.

But, the preference for adopting the mobile-based body scanner (see Table 4.11: P-value for Mobile-Based Body Scanner) was different between men and women (P-value > 0.0196).

Hence, hypothesis five was partially supported.

Table 4.11. P-value for Mobile-Based Body Scanner (Body Scanner C)

Method	Variances	Degree of Freedom	t Value	Probability > t
Pooled	Equal	213	2.35	0.0196**

Note: \*\* indicates significant difference at 95% confidence interval.

The preference between men and women for body scanner technologies had a significant difference only for the mobile-based body scanner (Body Scanner C). Whereas for the two other types of body scanners, there was no significant difference in preference between the genders.

Previous researchers suggested that women were more fashion concerned and had higher dissatisfaction regarding clothing fit (Al-Mousa, 2011; Loker et al., 2004). Data from the present research suggested that women were most skeptical about the accuracy of the mobile-based scanner which would in turn affect the fit of clothing produced using these measurements. This perception of inaccuracy from the mobile-based scanner could be a reason for women not favoring the mobile-based scanner.



## Chapter 5. Conclusion

Dissatisfaction with clothing fit has long been a problem for consumers of all ages (Istook, 2008). Acquisition of a correct set of measurements is the most important aspect of obtaining the correct fit (Apeagyei, 2010). Three-dimensional body scanning technology has been implemented as an alternative to the traditional tape measuring method given that 3D body scanners are efficient, quick, accurate, highly reproducible, and free of human errors (Braganca et al., 2015; Gill, 2015b; Loker et al., 2004). Many prior researchers have studied consumers' involvement with 3D body scanning technology (Al-Mousa, 2011; Apeagyei, 2010; Bindahman et al., 2012; Brownridge & Twigg, 2014; Fiore et al., 2003; Grogan et al., 2016; Heuberger et al., 2010; Lee, 2013; Loker et al., 2004; Ridgeway, 2018; Rzepka, 2011). However, no study was conducted to identify consumers' preferences of available body scanning technologies. This study was conducted to explore consumers' preferred body scanning technology using the Technology Acceptance Model (Davis, 1989).

An online survey was created to investigate the purpose statement and five resulting hypotheses. Following IRB approval, the survey was launched. A total of 220 usable surveys were collected in January of 2020. Data was cleaned and analyzed using SAS® to test the hypotheses.

The results indicated that consumers did not possess significantly different perceptions of usefulness across the three types of body scanners (traditional body scanner, suit-based body scanner, and mobile-based body scanner). The perceived ease of use did not vary significantly between the suit-based scanner and the traditional scanner, but the mobile-based scanner had a higher perceived ease of use than the traditional scanner. This difference may be due to the relative comfort of most consumers with mobile technology today.

Results also showed that men and women did have significantly different perceived ease of use for the suit-based scanner. It was also found that gender did not have any influence on preference for the traditional or the suit-based body scanner. However, there was a difference between the genders for the mobile-based scanner. Women found the suit-based scanner to have a lower perceived ease of use. This lack of perceived ease of use for the suit-based scanner may have been due to the fact that the scan suit is very tight on the subject and using the scanner required another person to view the consumer wearing the scan suit. Research has shown that women are less comfortable with their bodies and may have been less likely to want their figures viewed in a tight-fitting scan suit by another person (Al-Mousa, 2011; Loker et al., 2004).

### **5.1. Implications**

This study systematically explored consumers' preferences of body scanning technologies under the TAM (Davis, 1989) framework. This study identified consumers' perception on usefulness and ease of use across three types of body scanners. Moreover, this study also explored consumers' concerns regarding each type of technology. Results suggested that even though consumers do not have different perception on usefulness of the three types of body scanners, they have higher perceived ease of use for mobile-based body scanner, when compared to the other two. As discussed earlier, no other researcher had compared consumers' preference among different types of body scanners. Hence, very little was known about consumers' preference regarding body scanning technology. This study collected empirical data from the consumers across the United States and has made a contribution to the academy by investigating this topic.

Retailers and manufactures could also benefit from this research. Manufacturers of body scanning technology should utilize mobile-based platforms as consumers are more comfortable

and perceived them to be easier to use. Retailers who wish to implement body scanning technology should also investigate mobile technology.

Results also revealed that consumers are doubtful about the accuracy of the mobile-based body scanner and dissatisfied with the idea that they cannot use the measurements for shopping from other brands. Retailers should determine a method that would allow consumers to use mobile-based measurements to shop across many different brands.

## **5.2. Limitations and Future Research**

There were some limitations of this research. First, this study was able to collect a limited number of responses (only 220 valid responses) due to time and financial constraints. Moreover, the data was collected only in the U.S. Secondly, the data collection techniques included snowball sampling, which introduces bias in the responses. Additionally, much of the final data included responses from convenience sample of undergraduate students which may have affected the overall outcomes.

For the most part, data within this research was quantitative and with limited open-ended questions. The lack of qualitative data affects the ability to fully understand the opinions of consumers regarding body scanning technology. A qualitative research design with in-depth interviews could offer important insights into this topic.

Furthermore, among the demographic characteristics only gender was incorporated in the analysis. Inclusion of other variables like age, ethnicity, income, education, religion, occupation, and fashion leadership could add important insights to the knowledge. Finally, it was not possible to offer a real scanning experience using the three types of scanners to the participants. If the participants could experience the scanners practically then they might have different opinions about the scanners.

However, these limitations open doors for future research studies that can investigate a more diverse population and generalize the findings of the present study. Other important demographic variables such as ethnicity, income, religion, education, occupation, fashion consciousness could be incorporated in future studies. As for research design, qualitative research with in-depth interviews should be carried out. Future studies should also allow consumers to use the scanners in person and investigate their perceptions on usefulness and ease of use. As for the suit-based scanner, future studies should investigate how many body shapes can be accommodated for one size of the scan suit and determine if the measurements vary depending on the scan suit size that is worn. Moreover, future studies should investigate the effect of changed dimensional stability of the suit on the accuracy of measurements obtained using the suit.

## **Appendix A. Survey**

### **Consumers Preferred Body Scanning Technology: A Comparison**

The purpose of this study is to understand consumers' preferred type of body scanning technology and underlying reasons to the preferences. This study will be conducted using Qualtrics software (qualtrics.com). There are four sections of the survey. This survey may take 10-15 minutes to complete. To participate in the study, you must meet the requirements of both the inclusion and exclusion criteria. You must be at least 18 years old and reside in the US in order to participate in the study. There is no known risk associated with the study. For any additional information about this study please contact Saiful Islam at 225-916-6250 or at [sisla12@lsu.edu](mailto:sisla12@lsu.edu), or Dr. Casey R. Stannard at 225-578-2404 or at [stannard@lsu.edu](mailto:stannard@lsu.edu). You may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might entitled. Your responses to the survey will remain anonymous. This study has been approved by the LSU IRB. For questions concerning participant rights, please contact the IRB Chair, Dr. Dennis Landin at 578-8692, or [irb@lsu.edu](mailto:irb@lsu.edu). There are no gifts or compensation for participating in the survey; however, your responses will help identify preferred type of body scanning technology from consumers' point of view. By continuing this survey, you are giving consent to participate in this study.

## Introduction

Conventional 3D body scanners use white light, infrared or laser lights to scan the human body and find measurements of the body. There are new types of body scanners that use the camera of a cellphone to take pictures and find measurements of the body. Some body scanners can also determine the amount of body fat for users. The measurements found by body scanners are very accurate. Consumers can use these measurements to find better fitting clothing and to track health improvements like, changes in body fat and changes in key body measurements over time.

Survey procedures- You will be shown three types of body scanners and asked questions related to each.

## Body Scanner A

### About Body Scanner A

- 3D body scanner works using infrared depth sensors surrounding the person. The sensors send out light beams which bounce off the person and the distance can be calculated.
- Takes 10 seconds to scan the whole body and 30 seconds to process the data.
- It has an accuracy of +/- 5mm.
- Takes over 100 measurements of the body including: bust, waist, hip, height, etc.



### Scanning Procedure

- Locate a scanner- usually they are found at research labs or in some specialty stores.
- Step into curtained area and close curtain.
- Take off clothes and be in undergarments only.
- Step into the machine and put feet on the footprint guides.
- Grab handlebars on both sides and relax.
- Get scanned (~10 seconds).

### Outcomes:

- Measurements can be used for helping find correct sizes while shopping.
- Measurements can be used to have custom clothing made to fit your exact size.
- Using multiple scans over time, you can track changes in body shape and measurement.

Please select the level of agreement that fits your opinion best regarding Body Scanner A (explained above).

Question 1: I think my measurements will be taken quickly with this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 2: I think this technology will be able to measure my body for clothing fit.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 3: I think this technology will be able to measure my body to monitor body changes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 4: I think this technology will help me find the right size.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Question 5: I think this technology will help me to monitor my workout progress.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 6: I think this technology will take body measurements accurately.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 7: I think finding good fitting clothing will be easier with the help of this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 8: I think tracking body changes will be easier with the help of this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 9: I think this technology will be helpful in finding good fitting clothing.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 10: I think this technology will be helpful in tracking body changes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 11: I think this technology is easy to learn.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 12: I think this technology is easy to control.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 13: I think this technology is clear and understandable.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 14: I think I will have flexibility when using this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 15: I think it is easy to become skillful with this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 16: I think this technology is easy to use.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 17: I think I will use this technology in future.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much would you be willing to pay for a single body scan using this scanner?

---

Do you have any other thoughts or opinions about this body scanner?

---

## Body Scanner B

### About Body Scanner B

- Uses a cellphone camera, scan mat, pole and mobile app.
- Requires you to wear a special scan suit.
- Requires another person to take a cellphone video of you.
- Takes 30 seconds to scan the body.
- Measurements are highly accurate.
- Takes over 100 measurements of the body including: bust, waist, hip, height, etc.



### Scanning Procedure

- Locate a scanner- usually they are found at research labs or in gyms or you can purchase one for using at home.
- Change into special clothing suits (top and bottom) provided with the scanner.
- Use the pole to position hands around your body.
- Stand and position yourself using the scan mat provided with the scanner.
- Get someone to scan you using the camera of his/her mobile device.
- Get scanned (~30 seconds).

### Outcomes:

- Measurements can be used for helping find correct sizes while shopping.
- Measurements can be used to have custom clothing made to fit your exact size.

- Using multiple scans over time, you can track changes in body shape and measurement.

Please select the level of agreement that fits your opinion best regarding Body Scanner B (explained above).

Question 1: I think my measurements will be taken quickly with this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 2: I think this technology will be able to accurately measure my body for clothing fit.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 3: I think this technology will be able to accurately measure my body to monitor body changes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 4: I think this technology will help me find the right size.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 5: I think this technology will help me to monitor my workout progress.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 6: I think this technology will take body measurements accurately.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 7: I think finding good fitting clothing will be easier with the help of this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 8: I think tracking body changes will be easier with the help of this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 9: I think this technology will be helpful in finding good fitting clothing.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 10: I think this technology will be helpful in tracking body changes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 11: I think this technology is easy to learn.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 12: I think this technology is easy to control.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 13: I think this technology is clear and understandable.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 14: I think I will have flexibility when using this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 15: I think it is easy to become skillful with this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 16: I think this technology is easy to use.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 17: I think I will use this technology in future.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much would you be willing to pay for a single body scan using this scanner?

---

Do you have any other thoughts or opinions about this body scanner?

---



## Body Scanner C

### About Body Scanner C

- Uses a cellphone camera to record a video and an app.
- Measurements are highly accurate.
- Takes about 30 seconds to complete the scan.
- Takes nine upper body measurements and seven lower body measurements.



### Scanning Procedure

- Scan can be done anywhere, including at home.
- Change into tight fitting clothing.
- Open the app, position the phone for taking the video, and stand 6 feet away from the device.
- Follow the app's instructions. Hold your hands upright and make fists.
- Make a slow 360° spin to record the video.
- Stand out of the frame to complete scan.
- Get scanned (~30 seconds).

### Outcomes:

- Measurements can be used only with the app's sponsored clothing website.
- Measurements can be used on the clothing website to have custom clothing made to fit your exact size.

Please select the level of agreement that fits your opinion best regarding Body Scanner C (explained above).

Question 1: I think my measurements will be taken quickly with this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 2: I think this technology will be able to accurately measure my body for clothing fit.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 3: I think this technology will be able to accurately measure my body to monitor body changes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 4: I think this technology will help me find the right size.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 5: I think this technology will help me to monitor my workout progress.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 6: I think this technology will take body measurements accurately.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 7: I think finding good fitting clothing will be easier with the help of this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 8: I think tracking body changes will be easier with the help of this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 9: I think this technology will be helpful in finding good fitting clothing.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 10: I think this technology will be helpful in tracking body changes.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 11: I think this technology is easy to learn.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 12: I think this technology is easy to control.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 13: I think this technology is clear and understandable.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 14: I think I will have flexibility when using this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question 15: I think it is easy to become skillful with this technology.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 16: I think this technology is easy to use.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Question: 17: I think I will use this technology in future.

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much would you be willing to pay for a single body scan using this scanner?

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Do you have any other thoughts or opinions about this body scanner?

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## Summary Question

Considering the three body scanners which would you be **least** likely to use?



Body Scanner A



Body Scanner B



Body Scanner C

Why?

---

Considering the three body scanners which would you be **most** likely to use?



Body Scanner A



Body Scanner B



Body Scanner C

Why?

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How frequently would you be willing to use the scanner?

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## Demographics

Question 1: To which gender identity do you most identify?

- ☐ Female
- ☐ Male
- ☐ Transgender female
- ☐ Transgender male
- ☐ Gender variant/ Non-conforming
- ☐ Not listed \_\_\_\_\_
- ☐ Prefer not to answer

Question 2: Please select your age

- ☐ 18 – 25 Years
- ☐ 26 – 35 Years
- ☐ 36 – 45 Years
- ☐ 46 – 55 Years
- ☐ 56 – 65 Years
- ☐ 66 Years and older

Question 3: Please select your ethnic background

- ☐ Caucasian
- ☐ Hispanic/Latino
- ☐ African American
- ☐ Native American
- ☐ Asian/Pacific Islander
- ☐ Mixed Race
- ☐ Other

Question 4: Please select your level of education

- ☐ No schooling completed
- ☐ Elementary school to 8<sup>th</sup> grade
- ☐ Some high school
- ☐ High school graduate, diploma or the equivalent (for example: GED)

- ☐ Some college credit, no degree
- ☐ Trade/technical/vocational training
- ☐ Associate degree
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Professional degree
- ☐ Doctorate degree

Question 5: Are you a frequent gym user?

- ☐ Yes
- ☐ No

Question 6: Have you ever purchased or are you interested in custom fitted clothing?

- ☐ Yes
- ☐ No



## Appendix B. IRB Approval

### Re: Request for IRB Approval



Institutional R Board <irb@lsu.edu>

11/27/2019 11:58 AM



To: Saiful Islam

Hi,

The IRB chair reviewed your application, Consumers' Preferred Body Scanning Technology: A Comparison, and determined IRB approval for this specific application (IRB#E12018) is not needed. There is no manipulation of, nor intervention with, human subjects. Should you subsequently devise a project which does involve the use of human subjects, then IRB review and approval will be needed. Please include in your recruiting statements or intro to your survey, the IRB looked at the project and determined it did not need a formal review.

You can still conduct your study. It falls under a certain category that does not need IRB approval.

Thanks,

**Marie Laiche**

Graduate Assistant

Office of Research and Economic Development

Louisiana State University

131 David Boyd Hall, Baton Rouge, LA 70803

[mliche4@lsu.edu](mailto:mliche4@lsu.edu)

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## **VITA**

Saiful Islam, born in the city of Dhaka, Bangladesh worked in different apparel industries in Bangladesh for several years after receiving his bachelor's degree in Textile Engineering from the University of Chittagong, Bangladesh. He begun to work as a Merchandiser for different fashion retailers. As his interest in textiles and apparel grew, he decided to enter the Department of Textiles, Apparel Design, and Merchandising at Louisiana State University. Upon completion of his master's degree, he will begin work on his doctorate.